AMENDMENTS TO THE CLAIMS

1. (Currently amended) Equalization method for the cancellation of isofrequential interferers in signals received by array antennas ~~(ARY)~~ of base stations of a cellular mobile system, said signals $(\mathbf{y}(n))$ being received under the form of bursts of data symbols of a transmission burst, including a training sequence $(\{x_n\})$ known to the receiver and usable to estimate the impulse response of the transmission channel, said bursts received being demodulated, digitized, stored, and synchronized through discrimination of the training sequence, including the following steps:

a) spatial filtering of signals coming from the antennas $(\mathbf{y}(n))$, using a spatial filter ~~(BMF)~~ that combines among them corresponding n-th symbols of the bursts on the basis of n-th weights of a sequence of weights $(\mathbf{w}_{opt}(n))$ obtaining a beamformed received sequence $(\mathbf{y}_{out}(n))$;

b) time filtering ~~(CAMP)~~ data of the training sequence $(\{x_n\})$ for estimating a sequence of samples $(\mathbf{h}(n))$ of the impulse response of the transmission channel;

c) calculating a <u>mean</u> square error (e_n) originated from the comparison between the corresponding n-th samples of the estimate impulse response $(\mathbf{h}(n))$ and the beamformed <u>received</u> sequence $(\mathbf{y}_{out}(n))$;

d) joint optimization of said weights and samples $\left(\mathbf{w}_{opt}(n), \mathbf{h}_{opt}(n)\right)$ by minimizing a functional ~~(FUNZ)~~ corresponding to said mean square error (e_n);

e) time filtering of the signal $\left(y_{out}(n)\right)$ generated by said spatial filter ~~(BMF)~~ using a filter ~~(FADAT)~~ matched to the sequence of samples $\left(\mathbf{h}_{opt}(n)\right)$ of the impulse response of the transmission channel;

f) providing said sequence of samples of the impulse response of the transmission channel $\left(\mathbf{h}_{opt}(n)\right)$ and a sequence of sample at the output of ~~said~~ the matched filter ~~(FADAT)~~ to a Viterbi estimator for the detection of the received ~~data~~ signal;

g) updating the optimized values of said weights and samples $\left(\mathbf{w}_{opt}(n), \mathbf{h}_{opt}(n)\right)$, out of the time slot of the training sequence, through repetition of the previous steps **a)...f)**, replacing the symbols of the training sequence $\left(\{x_n\}\right)$ by a low delay estimated sequence $\left(\{\hat{x}'_n\}\right)$, thus rendering said equalization adaptive,

characterized in that while the previous steps are executed a parallel continuous monitoring of the power received on the antennas ~~(ARY)~~ for detecting possible peaks exceeding a given threshold in coincidence of the arrival of a strong non-stationary interferer is carried out, in case of detection of a peak over

threshold at an instant $\bar{n}$, step **d)** is modified for the all duration starting from the instant $\bar{n}$ up to an instant $\bar{n}+\Delta T$ of a transient devoted to the rejection of strong interferent outside ~~the~~ a midamble, by updating the sole weights $(\mathbf{w}_{opt}(n))$ of the spatial filter ~~(BMF)~~ maintaining the samples of the impulse response $(\mathbf{h}_{opt}(n))$ constant at the values they have at the instant $\bar{n}$, then the execution of unmodified step **d)** is restored at the end of said transient.

2. (Currently amended) Equalization method according to claim 1, characterized in that in absence of a strong non-stationary interferer the preceding step **d)** is executed in closed form by the following sub-steps:

- calculation of a spatial covariance matrix $\mathbf{R}_{yy}$ of the signals coming from the antennas $(\mathbf{y}(n))$, a covariance matrix $\mathbf{R}_{xx}$ of the data samples $(\{x_n\},\{\hat{x}'_n\})$, a cross-covariance matrix $\mathbf{R}_{xy}$ between data samples and inputs to the antennas $(\{x_n\},\mathbf{y}(n))$, and the Schur complement matrix $\mathbf{R}_s^{\perp}=\mathbf{R}_{xx}-\mathbf{R}_{xy}\mathbf{R}_{yy}^{-1}\mathbf{R}_{xy}^{*}$, being * the complex conjugate, of a matrix $\mathbf{R}=\begin{bmatrix}\mathbf{R}_{yy} & \mathbf{R}^{*}_{xy}\\ \mathbf{R}_{xy} & \mathbf{R}_{xx}\end{bmatrix}$;
- estimation of an eigenvector $\mathbf{h}_{opt}(n)$ of matrix $\mathbf{R}_s^{\perp}$ associated to the minimum module eigenvalue γ given by $\mathbf{h}^{*}\mathbf{R}_s^{\perp}\mathbf{h}=-\gamma$, said eigenvector including ~~said~~ the optimized samples;

- estimation of said optimized weights by calculating a vector $\mathbf{w}_{opt}(n)$ solution of the equation: $\mathbf{R}_{yy}\mathbf{w}_{opt}(n) = \mathbf{R}^{*}_{xy}\mathbf{h}_{opt}(n)$.

3. (Original) Equalization method according to claim 1, characterized in that in presence of a strong non-stationary interferer the preceding step **d)** is executed in closed form by the following sub-steps:

- calculation of a spatial covariance matrix $\mathbf{R}_{yy}(\bar{n} + \Delta T)$ of the signals coming from the antennas $(\mathbf{y}(n))$ and a complex conjugate cross-covariance matrix $\mathbf{R}^{*}_{xy}(n)$ between data samples and inputs to the antennas $(\{x_n\}, \mathbf{y}(n))$, matrix $\mathbf{R}_{yy}(\bar{n} + \Delta T)$ being calculated at instant $\bar{n}$, and then kept constant for the whole ΔT, using vectors $\mathbf{y}(n)$ obtained from the samples of signals on the antennas present in the stored bursts, starting from instant $\bar{n}$ up to the instant $\bar{n} + \Delta T$, while $\mathbf{R}^{*}_{xy}(n)$ being calculated at each instant n-th of the transient;
- estimation of said optimized weights by calculating a vector $\mathbf{w}_{opt}(n)$ solution of the equation: $\mathbf{R}_{yy}(\bar{n} + \Delta T)\,\mathbf{w}_{opt}(n) = \mathbf{R}^{*}_{xy}(n)\,\bar{\mathbf{h}}_{opt}$, where $\bar{\mathbf{h}}_{opt}$ is a vector including the samples of the impulse response at the instant $\bar{n}$.

4. (Currently amended) Equalization method according to claim 1, characterized in that in absence of a strong non-stationary

interferer the preceding step **d)** is executed in iterative form by the following sub-steps:

d1) assignment of arbitrary values, preferably null, to the elements of a structured triangular matrix $\overline{\mathbf{L}}(n)$, defines as follows: $\overline{\mathbf{L}}(n) = \begin{bmatrix} \mathbf{L}(n) & \mathbf{0} \\ \mathbf{U}(n) & \mathbf{L}_s(n) \end{bmatrix}$, wherein $\mathbf{L}(n)$ and $\mathbf{L}_s(n)$ are triangular matrices and $\mathbf{U}(n)$ is a square matrix, or more in general a rectangular one;

d2) assignment of arbitrary values, one of which non null, to the elements of a vector $\mathbf{h}_{opt}(n)$ storing ~~said~~ the optimized samples of the impulse response of the transmission channel;

d3) assignment of arbitrary values, one of which at least non null, to the elements of a vector $\mathbf{w}_{opt}(n)$ storing said weights of the spatial filter ~~(BMF)~~;

d4) updating of said structured matrix $\overline{\mathbf{L}}(n)$ applying at instant n-th the following iterative relation: $\left[\overline{\mathbf{L}}(n) \quad \mathbf{0}\right] = \left[\overline{\mathbf{L}}(n-1) \quad \mathbf{g}_n\right]\mathbf{Q}(n)$, where $\mathbf{g}_n$ is the following updating vector $\mathbf{g}_n = \begin{bmatrix} \mathbf{y}(n) \\ \mathbf{x}(n) \end{bmatrix}$ structured in two component vectors, out of which: $\mathbf{y}(n) = \left[y_1(n), y_2(n), \ldots., y_M(n)\right]^T$ is a first vector whose M elements are symbols coming from M antennas at instant n-th, present in a same number of stored bursts, and

$\mathbf{x}(n) = [x_n(n), x_{n+1}(n), \ldots, x_{n+L-1}(n)]^T$ is a second vector whose L elements are stored symbols of the transmitted training or estimated sequence $(\{x_n\}, \{\hat{x}'_n\})$ respectively, assuming a duration of the impulse response equal to L symbols; being $\mathbf{Q}(n)$ a matrix transformation of unitary rotation, implemented through a sequence of elementary transformations $\mathbf{Q}_0, \mathbf{Q}_1, \cdots$, that applied to $[\bar{\mathbf{L}}(n-1) \quad \mathbf{g}_n]$ produces the cancellation of column $\mathbf{g}_n$ introducing a zero for each elementary transformation;

d5) determination of a weight vector $\mathbf{h}_n$ through the following expression: $\mathbf{L}_s(n)\mathbf{L}_s^*(n)\mathbf{h}_n = \mathbf{h}_{opt}(n-1)$, according to which ~~said~~ the vector of optimum samples is updated as follows $\mathbf{h}_{opt}(n) = \dfrac{\mathbf{h}_n}{\mathbf{h}_n^*\mathbf{h}_n}$;

d6) updating of ~~said~~ the optimum weight vector through the following expression: $\mathbf{L}^*(n)\mathbf{w}_{opt}(n) = \mathbf{U}^*(n)\mathbf{h}_{opt}(n)$.

5. (Currently amended) Equalization method according to claim 4, characterized in that said expression calculated at ~~step h5)~~ step d5) is divided into two calculation phases, introducing an unknown intermediate vector $\mathbf{u}_n$ defined by the following first equation: $\mathbf{L}_s^*(n)\mathbf{h}_n = \mathbf{u}_n$, being $\mathbf{u}_n$ a solution of the following second equation: $\mathbf{L}_s(n)\mathbf{u}_n = \mathbf{h}_{opt}(n-1)$ that replaced in its turn in the starting equation gives $\mathbf{h}_n$, simplifying the relevant calculation.

6.(Currently amended) Equalization method according to claim 4, characterized in that ~~said~~ the matrix $\overline{\mathbf{L}}(n-1)$ is multiplied by $\sqrt{\lambda}$, where λ is an arbitrary real constant, lower than one unit, selected in relation to the non stationariness of the channel.

7.(Currently amended) Adaptive equalization method according to claim 1, characterized in that, in presence of a strong non-stationary interferer the preceding step **d)** is executed in iterative form by the following sub-steps:

h1) advanced updating within the symbol time $\bar{n}$ of a sole triangular matrix $\mathbf{L}$ belonging to a structured triangular matrix $\overline{\mathbf{L}}(n)$, defined as follows: $\overline{\mathbf{L}}(n)=\begin{bmatrix}\mathbf{L}(\bar{n}+\Delta T) & \mathbf{0}\\ \mathbf{U}(n) & \mathbf{L}_s(n)\end{bmatrix}$, wherein $\mathbf{L}(\bar{n}+\Delta T)$ and $\mathbf{L}_s(n)$ are triangular matrices and $\mathbf{U}(n)$ is a square matrix, or more in general a rectangular one; the advanced updating of said matrix $\mathbf{L}$ being executed using vectors $\mathbf{y}(n)$ obtained from the samples of signals on the antennas, present in the stored bursts, starting from instant $\bar{n}$ up to an instant $\bar{n}+\Delta T$; matrix $\mathbf{L}$ being calculated at instant $\bar{n}$ and then kept constant for the whole ΔT;

h2) starting from instant $\bar{n}$ up to an instant $\bar{n}+\Delta T$, updating of matrices $\mathbf{U}(n)$ and $\mathbf{L}_s(n)$ of said triangular matrix $\overline{\mathbf{L}}(n)$ applying at instant n-th the following iterative relation: $[\overline{\mathbf{L}}(n)\ \ \mathbf{0}] = [\overline{\mathbf{L}}(n-1)\ \ \mathbf{g}_n]\mathbf{Q}(n)$, where $\mathbf{g}_n$ is the following updating

vector $\mathbf{g}_n = \begin{bmatrix} \mathbf{y}(n) \\ \mathbf{x}(n) \end{bmatrix}$ structured in two component vectors, out of which: $\mathbf{y}(n) = [y_1(n), y_2(n), \ldots, y_M(n)]^T$ is a first vector whose M elements are symbols coming from M antennas at instant n-th, present in a same number of stored bursts, and $\mathbf{x}(n) = [x_n(n), x_{n+1}(n), \ldots, x_{n+L-1}(n)]^T$ is a second vector whose L elements belong to said low delay estimated sequence $(\{\hat{x}'_n\})$, assuming a duration of the impulse response equal to L symbols; being $\mathbf{Q}(n)$ a matrix transformation of unitary rotation, implemented through a sequence of elementary transformations $\mathbf{Q}_0, \mathbf{Q}_1, \cdots$, that applied to $[\overline{\mathbf{L}}(n-1) \quad \mathbf{g}_n]$ produces the cancellation of column $\mathbf{g}_n$ introducing a zero for each elementary transformation;

h3) updating of ~~said~~ <u>the</u> optimum weight vector through the following expression: $\mathbf{L}^*(\bar{n} + \Delta T)\mathbf{w}_{opt}(n) = \mathbf{U}^*(n)\overline{\mathbf{h}}_{opt}$, where $\overline{\mathbf{h}}_{opt}$ is a vector including the samples of the impulse response at the instant $\bar{n}$.

8. (Original) Equalization method according to claim 7, characterized in that said advanced updating of the sole triangular matrix $\mathbf{L}$, is made applying the generic said elementary transformation $\mathbf{Q}_i$ to the first M elements of the i-th column of said triangular matrix $\overline{\mathbf{L}}(n)$, where M is the order of matrix $\mathbf{L}$,

repeating the elementary transformation $\mathbf{Q}_i$ for all the values of index i and storing the transformations occurred.

9. (Currently amended) Equalization method according to claim 7, characterized in that ~~said~~ the matrix $\overline{\mathbb{L}}(n-1)$ is multiplied by $\sqrt{\lambda}$, where λ is an arbitrary real constant, lower than one unit, selected in relation to the non stationariness of the channel.

10. (Previously presented) Equalization method according to claim 1, characterized in that, coinciding with any new symbol of low delay estimated sequence $(\{\hat{x}'_n\})$, the L elements of said vector $\mathbf{x}(n)$ are replaced by a same number of symbols copied as a whole from the path selected in the trellis at the present symbol time, preventing by this the propagation of errors in the joint estimate of said optimum weights and channel impulse response samples $(\mathbf{w}_{opt}(n), \mathbb{h}_{opt}(n))$.

11. (Currently amended) Equalization method according to claim 1, characterized in that when said training sequence $(\{x_n\})$ is included in a midamble of the transmission burst, said equalization of the step **g)** starts from a first end of the midamble and proceeds towards the end of the burst, previously stored and synchronized, and afterwards it restarts from the second end of the midamble towards the other end of the burst, using estimated data of ~~the~~ a

first semiburst to have a longer group of estimated data for the equalization of ~~the~~ a second semiburst.

12. (Currently amended) Equalizer for receivers of base stations of a cellular mobile system, in particular for the cancellation of isofrequential interferers in signals received by array antennas ~~(ARY)~~ of base stations of a cellular mobile system, said signals $(\mathbf{y}(n))$ being received under the form of bursts of data symbols of a transmission burst, including a training sequence $(\{x_n\})$ known to the receiver and usable to estimate the impulse response of the transmission channel, said bursts received being demodulated, digitized, stored, and synchronized through discrimination of the training sequence, including:

- a spatial filter ~~(BMF)~~ of signals coming from the antennas $(\mathbf{y}(n))$ that combines among them corresponding n-th symbols of the bursts on the basis of n-th weights of a sequence of weights $(\mathbf{w}_{opt}(n))$ obtaining a beamformed received sequence $(\mathbf{y}_{out}(n))$;
- a time filter ~~(CAMP)~~ for filtering data of the training sequence $(\{x_n\})$ and estimating a sequence of samples $(\mathbf{h}(n))$ of the impulse response of the transmission channel;
- means ~~(Σ)~~ for calculating a mean square error (e_n) originating from the comparison between the corresponding n-th samples of

the estimate impulse response $(\mathbf{h}(n))$ and the beamformed sequence $(\mathbf{y}_{out}(n))$;

- joint optimization means ~~(FUNZ)~~ for the joint optimization of said weights and samples $(\mathbf{w}_{opt}(n), \mathbf{h}_{opt}(n))$ and to minimize a functional ~~(FUNZ)~~ corresponding to said mean square error (e_n);
- a time matched filter ~~(FADAT)~~ of the signal $(y_{out}(n))$ generated by said spatial filter ~~(BMF)~~, matched to the sequence of samples $(\mathbf{h}_{opt}(n))$ of the impulse response of the transmission channel;
- a Viterbi estimator ~~(STIM)~~ for estimating the symbols $(\{\hat{x}_n\})$ of the transmission burst corresponding to the sequence coming out from the time matched filter ~~(FADAT)~~;
- means ~~(DECTEMP)~~ for replacing out of the time slot of the training sequence the symbols of the training sequence $(\{x_n\})$ with a low delay estimated sequence $(\{\hat{x}'_n\})$, thus rendering said equalization adaptive,

characterized in that it further includes:

- means ~~(PICRIV)~~ for the continuous monitoring of the power received on the antennas ~~(ARY)~~ and for detecting possible peaks exceeding a given threshold in coincidence of the arrival of a strong non-stationary interferer;

- selection means ~~(PICSEL, SWT)~~ controlled by ~~said~~ the continuous monitoring means ~~(PICRIV)~~ suitable for the selection of ~~said~~ means ~~(SYSTOL1, 3, 4, 5)~~ for the joint optimization of weights and samples, in case a detection of a peak over threshold doesn't occur, and for the selection of means ~~(SYSTOL2, SYSTOL5)~~ devoted to the rejection of a strong interferent in case of detection of a peak over threshold occur at an instant $\bar{n}$ outside the midamble; the latter means being operative for the all duration starting from the instant $\bar{n}$ up to an instant $\bar{n}+\Delta T$ of a rejecting transient and being arranged for updating the sole weights $(\mathbf{w}_{opt}(n))$ of the spatial filter ~~(BMF)~~ maintaining the samples of the impulse response $(\mathbf{h}_{opt}(n))$ constant at the values they have at the instant $\bar{n}$; the preceding means for the joint optimization ~~(SYSTOL1, 3, 4, 5)~~ being restored at the end of said rejection transient.

13. (Currently amended) Equalizer according to claim 12, characterized in that in absence of strong non-stationary interferer said joint optimization means ~~(SYSTOL1, 3, 4, 5)~~ are constitute by the following means:

- first delay means ~~(RIT)~~ for delaying with a fixed delay (D) an algebraic vector $\mathbf{y}(n)$ of M elements, as many as the antennas, whose elements are symbols of the stored bursts of the signal coming from the antennas;

- a first systolic array ~~(SYSTOL1)~~ receiving said vector $\mathbf{y}(n)$ and symbols of said training sequence $(\{x_n\})$ or estimated low delay ones, organized as in an algebraic vector $\mathbf{x}(n)$ of L elements, equal to the length of the channel impulse response, and updating, coinciding with each symbol time n-th, a triangular matrix $\overline{\mathbf{L}}(n) = \begin{bmatrix} \mathbf{L}(n) & \mathbf{0} \\ \mathbf{U}(n) & \mathbf{L}_s(n) \end{bmatrix}$ image of said first systolic array ~~(SYSTOL1)~~ in which the elements $\mathbf{L}(n)$ and $\mathbf{L}_s(n)$ are also triangular matrices, and $\mathbf{U}(n)$ is rectangular, or square;
- a second systolic array ~~(AUTOVET)~~, said second systolic array receiving ~~said~~ the element $\mathbf{L}_s(n)$ and updating a vector $\mathbf{h}_{opt}(n)$ whose elements correspond to the optimized samples of the impulse response,
- a third systolic array ~~(SYSTOL5)~~, placed in cascade to the second, receiving said elements $\mathbf{L}(n)$ and $\mathbf{U}(n)$, the vector $\mathbf{h}_{opt}(n)$, and updating a vector $\mathbf{w}_{opt}(n)$ whose elements correspond to the optimized weights.

14.(Currently amended) Equalizer according to claim 13, characterized in that said second systolic array ~~(AUTOVET)~~, is further divided in the cascade of two systolic arrays ~~(SYSTOL3, SYSTOL4)~~ having identical triangular structure, of which the

upstream array ~~(SYSTOL3)~~ receives said element $\mathbf{L}_s(n)$, and the previous vector $\mathbf{h}_{opt}(n-1)$ of the downstream array, and calculates an intermediate vector $\mathbf{u}_n$ supplying it to the downstream array ~~(SYSTOL4)~~, reached also by element $\mathbf{L}_s^*(n)$, for the calculation of ~~said~~ the vector $\mathbf{h}_{opt}(n)$.

15.(Currently amended) Equalizer according to claim 12, characterized in that in presence of strong non-stationary interferer ~~said~~ the joint optimization means ~~(SYSTOL2, SYSTOL5)~~ are constitute by the following means:

- first delay means ~~(RIT)~~ for delaying with a fixed delay (D) an algebraic vector $\mathbf{y}(n)$ of M elements, as many as the antennas, whose elements are symbols of the stored bursts of the signal coming from the antennas;
- a first systolic array ~~(SYSTOL2)~~ receiving ~~said~~ the vector $\mathbf{y}(n)$ and the symbols of said low delay estimated sequence $\left(\left\{\hat{x}'_n\right\}\right)$ organized as in an algebraic vector $\mathbf{x}(n)$ of L elements, equal to the length of the channel impulse response, and updating, coinciding with each symbol time n-th, a matrix $\overline{\mathbf{L}}(n) = \begin{bmatrix} \mathbf{L}(\bar{n}+\Delta T) & \mathbf{0} \\ \mathbf{U}(n) & \mathbf{L}_s(n) \end{bmatrix}$ image of said first systolic array

~~(SYSTOL2)~~ in which the elements $\mathbf{L}(n)$ and $\mathbf{L}_s(n)$ are also triangular matrices, and $\mathbf{U}(n)$ is rectangular or square matrix ;

- second delay means ~~(FIFO)~~ suitable for delay element $\mathbf{L}$ calculated at instant $\bar{n}$ for the whole ΔT;
- a second systolic array ~~(SYSTOL5)~~, placed in cascade to the first, receiving said elements $\mathbf{L}(n)$ and $\mathbf{U}(n)$, a vector $\overline{\mathbf{h}}_{opt}$ including the samples of the impulse response at the instant $\bar{n}$, and updating a vector $\mathbf{w}_{opt}(n)$ whose elements correspond to the optimized weights.

16. (Currently amended) Equalizer according to claim 13, characterized in that ~~said~~ the vectors $\mathbf{y}(n)$ and $\mathbf{x}(n)$ reach in column, in the order indicated, the input of the cells of said first systolic array ~~(SYSTOL1, SYSTOL2)~~ corresponding to the elements of the first column of said matrix $\overline{\mathbf{L}}(n)$, the whole of cells of the triangular matrix including the calculation means of the following matrix relation:

$$[\alpha \quad out] \leftarrow [\alpha\sqrt{\lambda} \quad in]\frac{1}{\sqrt{1+|\rho|^2}}\begin{bmatrix} 1 & \rho \\ \rho^* & -1 \end{bmatrix}$$

where:

- α pointed by the arrow indicates the new content of the cell;

λ is an arbitrary real constant ≤ 1, selected in relation to the non stationariness of the channel

- *out* is an output signal;
- *in* is a signal entering each cell; and
- ρ is a both input and output signal, calculated as follows:

$$\rho = \frac{in}{\alpha\sqrt{\lambda}};$$

the cells corresponding to the elements of the main diagonal of said matrix $\overline{\mathbf{L}}(n)$ containing the alternative calculation means, such for which the signal ρ is only an output one, the signal *out* is absent, and the content α is updated as follows:

$$\alpha \leftarrow \sqrt{\lambda|\alpha|^2 + |in|^2}.$$